

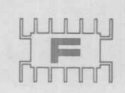
ZINC OXIDE



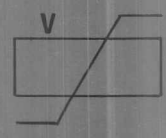
transient voltage suppressors (TRANSIENT CLIPPERS)

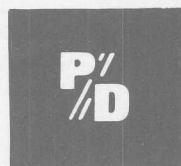
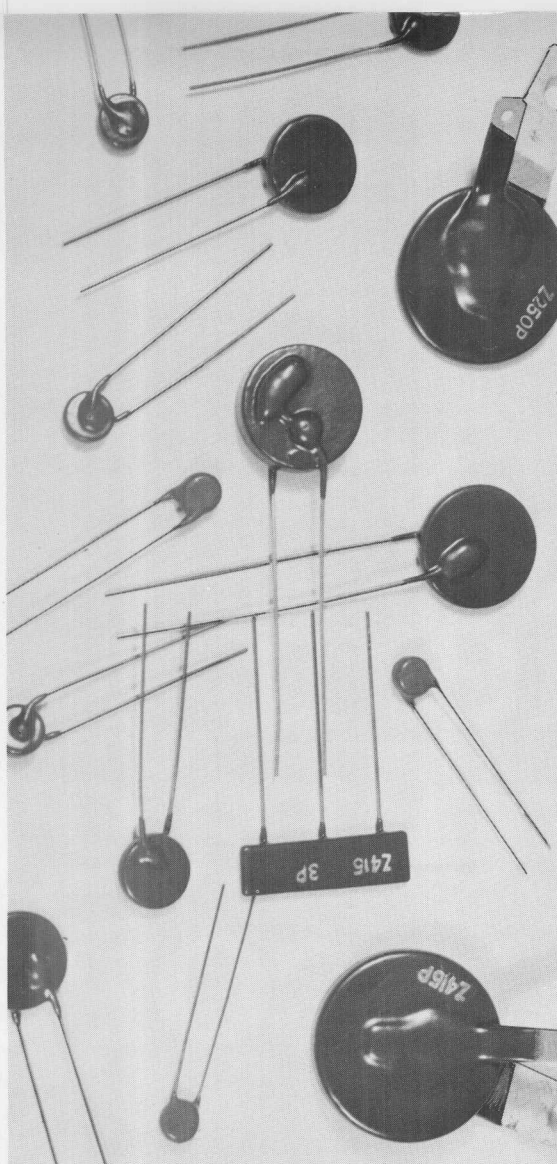
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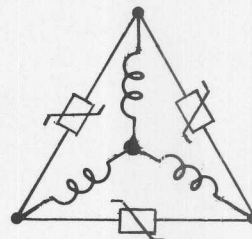
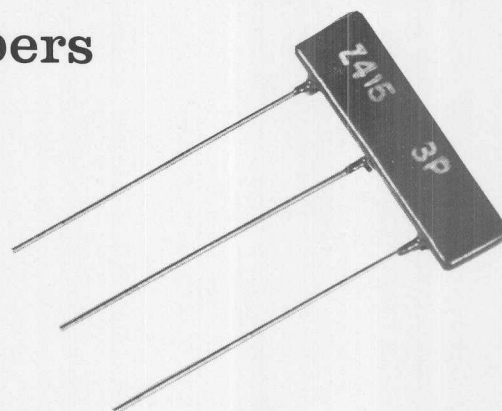
Power Development Transient Clippers are specifically designed to suppress voltage transients. The family is now extended to include five ranges of disc types with progressively higher energy ratings and there are two high performance chassis mounting ranges. The very high non linear index, virtually instantaneous response and high current/energy withstand, offer a standard of protection far superior to their predecessors. Energy withstand is increased, clipping voltages reduced and the wider selection provided by this extended range enables the designer to seek an even better standard of protection with greater economy.

At rated voltage Transient Clippers are almost a pure capacitor passing only a few microAmps even at 50Hz. In the presence of a transient the semi-conductor junctions 'turn on' presenting a low resistance path and suppressing the transient to an acceptable level. Immediately the transient is passed, the Clipper recovers its original high resistance.

Essentially a back to back symmetrical diode similar to a zener, Transient Clippers are manufactured in the U.K. from Zinc Oxide which is mixed with other rare metal oxides then pressed and sintered according to our own patented process. Contacts are made and wires attached. The devices are then coated in a fluidised bed with a tough epoxy powder finish which is moisture and flame resistant.

Three Phase Transient Clippers

This range of Transient Clippers is designed for 3-phase operation to reduce the transient voltage which can appear between phases. The Zinc Oxide module is star connected with an insulated neutral. The module is epoxy coated with tinned copper leads minimum 40mm long. It is suitable for use on motors up to 1hp (1000watts)



Max. ¹ volts rms Ph. to Ph.	Type ⁶ ref.	Varistor ² voltage at 1mA (min ^m) DC	Ref. phase to earth V rms	Joules/ phase ⁴	Clamping ³ voltage Ph. to Ph. at 10A
250	Z220P3	350	127	15	680
420	Z380P3	600	220	18	1000
460	Z415P3	650	240	20	1150
484	Z440P3	685	255	25	1250

In keeping with our policy of continual development and improvement we reserve the right to amend this specification without notice.

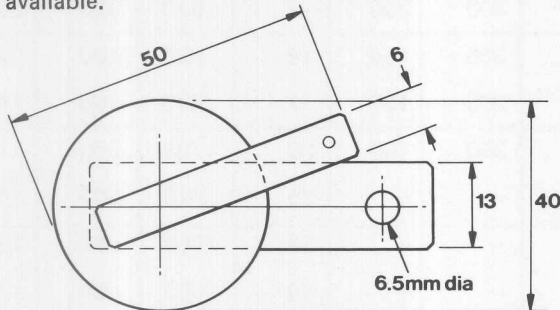
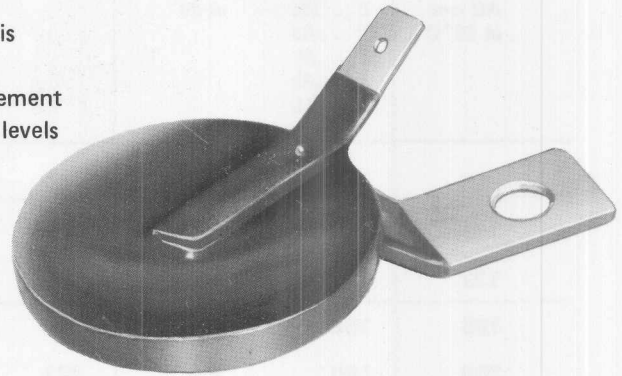
LP Range Transient Clippers

Effective transient suppression in high current high energy circuits.

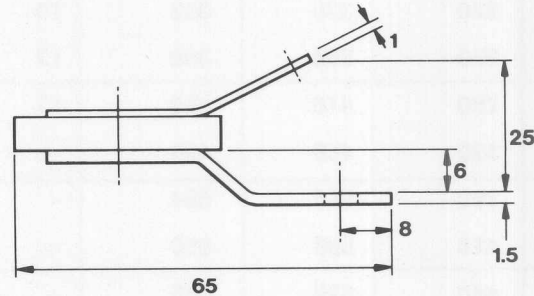
'P' stands for POWER . PERFORMANCE . PROTECTION — and this is what the LP RANGE OF TRANSIENT CLIPPERS has to offer.

This new range makes use of a large diameter high mass Zinc Oxide element to provide repeatable safe protection against high currents and energy levels that would destroy a standard disc type in one shot.

Single hole chassis mounting is robust and also combines positive earthing with good heat transfer performance. The live spade terminal also permits quick installation. The LP range Transient Clippers withstand Peak Currents up to 8kA. Energy absorption of up to 450 Joules. Intermediate and high voltage ratings are available.



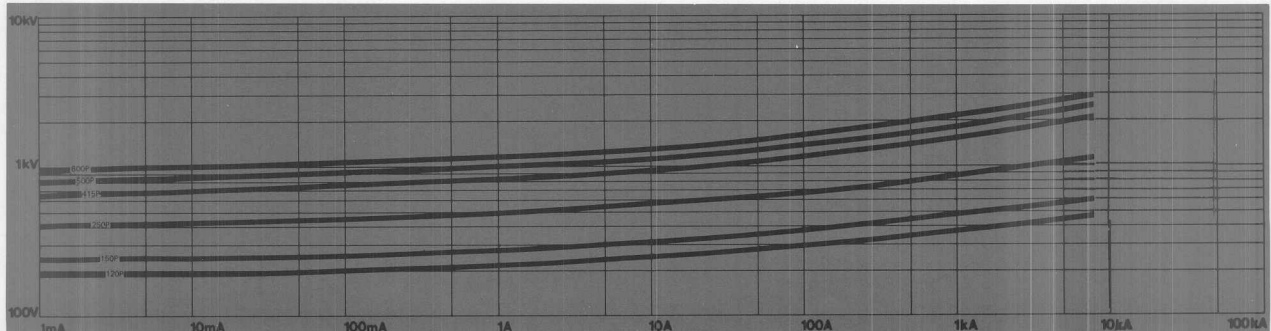
All dimensions in mm



LP TYPE 8kA (8/20 μ s)

Max. volts rms	Type ref. 6	Max. voltage ¹ DC	Min. varistor ² voltage at 1mA	Energy joules	Clamping voltage at 100A 8/20 μ s	Capacitance pF
132	Z120LP	175	187	100	325	8000
165	Z150LP	220	233	120	420	7000
200	Z180LP	260	283	130	490	6000
250	Z220LP	320	343	160	600	4500
275	Z250LP	370	389	180	650	4000
320	Z280LP	410	436	210	750	3700
352	Z320LP	470	498	230	850	3500
420	Z380LP	560	594	260	1000	3200
460	Z415LP	615	645	290	1100	3000
484	Z440LP	640	685	320	1150	2800
550	Z500LP	710	778	350	1250	2400
632	Z575LP	825	894	375	1430	1800
660	Z600LP	850	933	400	1500	1600
726	Z660LP	950	1027	450	1650	1400

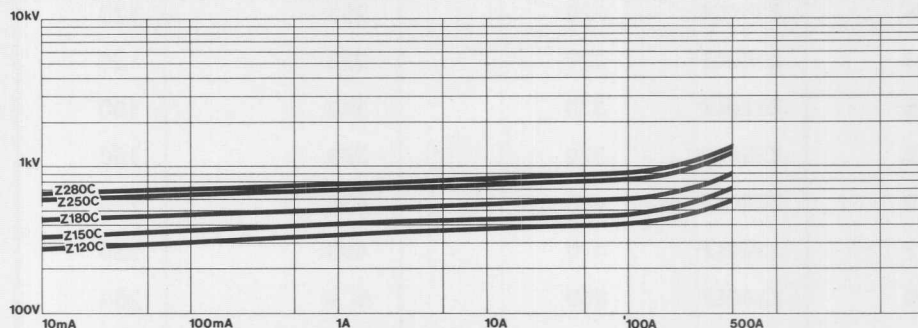
To improve readability some curves have been omitted but the information may be obtained by pro-rating.



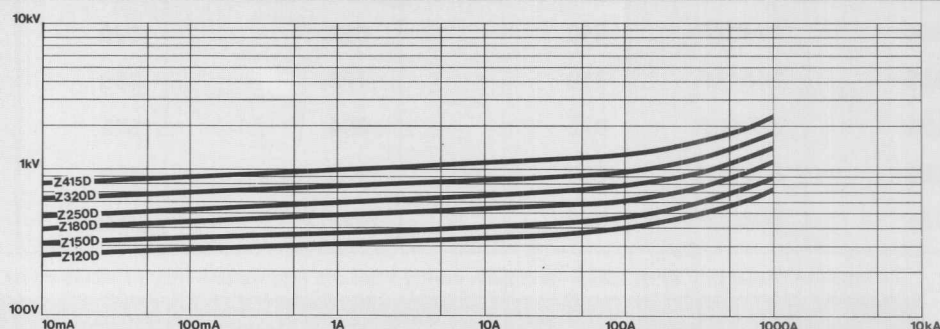
Transient Clippers are designated by their system voltage and performance letter, e.g. A 250 volt 1000A device is a Z250D.

Max. cont. volts AC rms at 25°C	Type ⁶ ref. Z.../C Z.../D Z.../F Z.../G Z.../J	Max. ¹ cont. DC volts at 25°	Varistor ² voltage min.	C RANGE 12J max. (7mm) 500A 8/20 μ s ⁴				D RANGE 30J max. (10mm) 1000A 8/20 μ s ⁴			
				Joules ⁴	Clamping voltage ³	m Watts cont. ⁵	cap. pF	Joules ⁴	Clamping voltage ³	m Watts cont. ⁵	cap. pF
95	85	123	135	3	240	250	300	—	—	—	—
121	110	157	171	5	330	250	250	8	300	300	420
132	120	172	187	6	370	250	250	10	325	325	350
165	150	214	233	7	410	250	200	10	385	350	300
200	180	260	283	8	510	300	200	12	510	350	260
250	220	325	353	10	600	300	150	14	600	400	220
275	250	358	389	12	650	300	150	17	650	400	190
320	280	416	450	12	780	300	100	20	780	500	175
352	320	458	498	—	—	—	—	25	845	500	160
420	380	546	594	—	—	—	—	25	1000	550	135
460	415	598	650	—	—	—	—	30	1090	550	120
484	440	629	685	—	—	—	—	—	—	—	—
550	500	715	778	—	—	—	—	—	—	—	—
632	575	821	894	—	—	—	—	—	—	—	—
726	660	944	1027	—	—	—	—	—	—	—	—

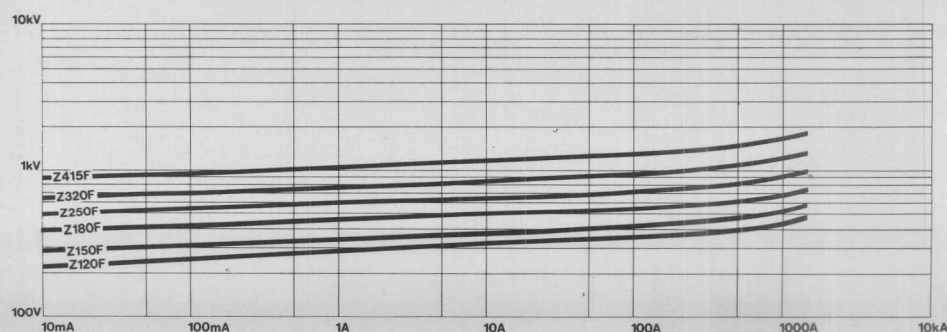
C RANGE



D RANGE



F RANGE



F RANGE 50J max. (14mm) 2000A 8/20 μ s ⁴				G RANGE 140J max. (18mm) 4000A 8/20 μ s ⁴				J RANGE 250J max. (23mm) 6000A 8/20 μ s ⁴			
Joules ⁴	Clamping voltage ³	m Watts cont. ⁵	cap. pF	Joules ⁴	Clamping voltage ³	m Watts cont. ⁵	cap. pF	Joules ⁴	Clamping voltage ³	m Watts cont. ⁵	cap. pF
10	210	500	1200	—	—	—	—	—	—	—	—
10	290	500	1100	30	285	600	1200	55	275	1100	2400
20	320	550	1000	40	320	600	1000	65	320	1100	2000
20	390	550	850	40	400	650	1000	70	380	1150	1700
25	510	600	700	50	520	650	800	80	500	1150	1350
30	610	600	600	55	620	700	650	120	610	1200	1000
35	660	600	550	70	685	700	550	120	680	1200	950
35	810	600	550	75	820	700	900	130	780	1200	950
40	900	650	500	85	910	750	850	150	850	1250	900
40	1120	650	450	90	1080	750	800	165	1050	1250	900
50	1220	650	400	100	1190	800	800	190	1120	1300	850
—	—	—	—	105	1210	850	750	200	1190	1350	850
—	—	—	—	120	1450	900	750	215	1360	1400	800
—	—	—	—	135	1540	950	700	230	1500	1450	800
—	—	—	—	140	1750	1000	700	250	1720	1500	750

1 DC smooth < 2% ripple, Unsmoothed (rectified AC) use AC voltages figures.

2 Pulse measurement at 1mA.

3 Clamping voltage is given at the current level for which a life of 10⁶ operations can be expected. C = 3A, D = 5A, F = 10A, G = 20A, J = 30A

4 Max. current single shot operation with less than 10% movement in varistor voltage. See multi shot evaluation curves.

5 Normal leakage current at rated voltage is well below this figure. Heat lost through wires is substantial and suitable mounting can considerably enhance these figures.

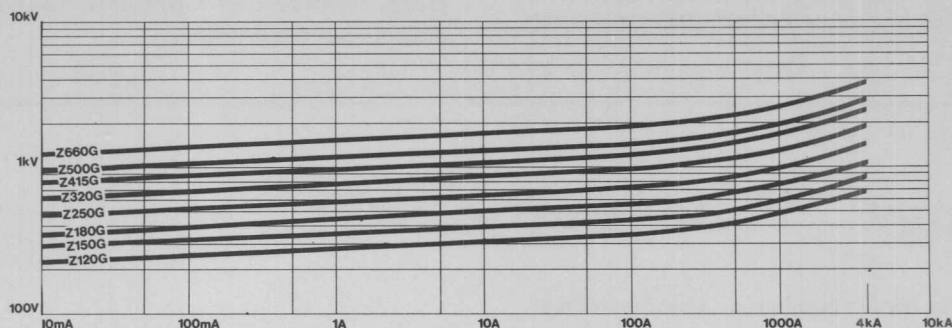
6 The type reference number also gives the recommended system voltage allowing a 10% margin from the maximum voltage figures, thus permitting fluctuations and higher than ambient temperatures.

To improve readability some curves have been omitted but the information may be obtained by pro-rating.

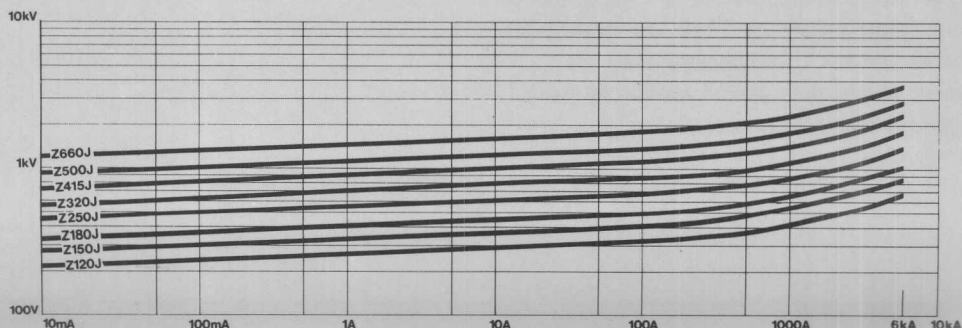
The characteristics curves shown are typical.

More specific information on tolerances, etc. is available on request.

G RANGE



J RANGE



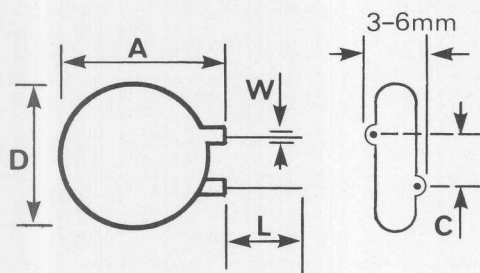
Methods of protection ~ Why Transient Clippers?

There are many ways to suppress transients: — the traditional CR circuit — spark gaps — diodes — crowbars — silicon carbide

- High Non Linear Index
- Fast Response (a few nanoseconds)
- Low Protection Level (clamping voltage)
- Low Drain Current (typically microAmps)
- High Current Withstand: 1kA to 6kA (up to 20kA on chassis mounting types)

varistors etc., but none of these can combine the cumulative advantages of Transient Clippers, viz:

- High Energy Withstand: (up to 250J on wired discs, more on chassis mounting types)
- Suitable for AC and DC Circuits
- Small Package Size
- Wide range of Voltage/Current ratings
- Low Cost



DIMENSIONS mm (nominal)

Range	A	C	D	W	L
Z ... C	13	7.8	9	0.8 ϕ	30
Z ... D	15	7.8	11	0.8 ϕ	30
Z ... F	20	7.8	16.5	0.8 ϕ	30
Z ... G	23	7.8	19	0.8 ϕ	30
Z ... J	29	7.8	24	0.9 ϕ	30

ZOMM's for Electro Magnetic Pulse protection

The enormous Electro Magnetic Pulse generated by a high altitude nuclear explosion induces a high transient voltage into any unshielded conductor — overhead lines, telephones, signal lines etc. Typically double figures in kV with a rate of rise of a few nanoseconds. The effect of such a pulse is devastating on low voltage semi-conductors now widely employed throughout communications and defence equipment.

Traditional spark gaps, silicon carbide V.D.R's etc. Simply do not respond quickly enough to give protection and even the high speed response of zinc oxide TRANSIENT CLIPPERS

can be negated by the inductance of long wires connecting them to source and earth.

ZOMMs are designed to overcome this problem by using specially formulated metal oxide elements. Encapsulated in single or multichannel modules they offer minimum inductance with fastest possible response and maximum protection.

Custom-designed, hand-made and individually Laboratory tested ZOMMs are available for virtually any voltage and energy rating. Telephone our engineers so that we can come and discuss your requirements.

HV Range Voltage up to 3kV

Primarily designed for application in H.V. stabilisation and H.V. lampstarting gear the range now includes single elements up to 3kV continuous rating. Dissipation up to 2 watts can be greatly enhanced by suitable mounting. Their low capacitance makes them suitable for use at r.f. and because they are suitable for use in series chains they can be applied in many application previously considered impractical. Ask for details.



Source of Transient

Motors

Transformers

Fluorescent chokes

Relays

Starter coils

Atmospheric/lightning

Induced switching effects

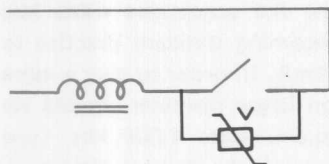
Actuators

Solenoids

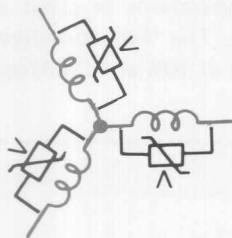
Spot Welders

Electromagnets

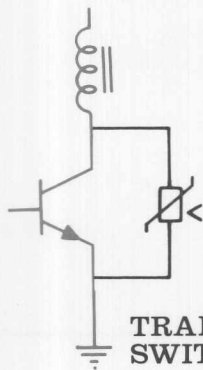
Discharge Lamps



RELAY CONTACT PROTECTION



STAR AND DELTA MOTOR PROTECTION



TRANSISTOR SWITCHING

Why surge protection?

Since the beginning of electrical engineering designers have had to protect installations against the effects of unwanted over voltages. The most obvious sources being lightning and switching. Earlier designs using generous clearances, heavy insulation, thermionic valve electronics presented few problems. Modern sophisticated designs in both electronics and power with high component densities and low withstand semiconductors, demand an effective method of over-voltage protection.

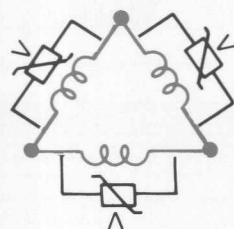
TRANSIENT CLIPPERS are specifically designed to give a high standard of protection against voltage transients permitting electrical designs to be SAFER, MORE RELIABLE and MORE ECONOMICAL.

SOURCE

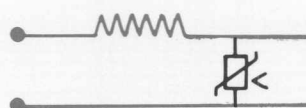
In any electrical circuit a rapid change in current will generate voltage transient. Its size and duration will depend on the rate of change of current and circuit inductance and capacitance ($L \frac{di}{dt}$). On the left are listed some of the many equipments which habitually generate transients capable of causing damage to sensitive equipment.

SENSITIVE AREAS

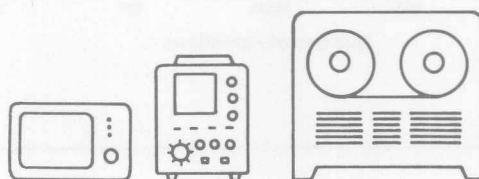
On the right are listed some of the many equipments making use of semiconductor devices which are likely to fail if exposed to voltage transients. Properly protected with Transient Clippers these devices are not only made more reliable but also safer and frequently cheaper because less expensive semiconductor devices can be employed.



VOLTAGE STABILISATION



TV. OSCILLOSCOPE, COMPUTER PROTECTION



Sensitive Areas

Power Supplies

Speed controllers

Timers

Programmers

Amplifiers

Inverters

Oscilloscopes

Mains filters

Amusement Machines

Telephony

Instrumentation

Contact Protection

Insulation

Cash Registers

Computers

Auto washing machines

Cooker controls

Security Systems

Dimmers

Spot Welder Timers

Lighting Controllers

Television

Proximity switches

Sensoric

Street lighting

Medical analysis equipment

If you are designing or using equipment where any item in the left hand column is associated with any item in the right hand column you need some form of transient suppression to achieve optimum life and economy.

Always FIT **P/D** TRANSIENT CLIPPERS

How to select and specify

If the source of the transient is known - (motor - relay - etc.)

- 1) Select voltage rating based on system voltage (Transient Clippers all have a 10% safety margin in their maximum rating to allow for system fluctuations).
- 2) Establish the peak current normally flowing in the coil and the number of operations required.
- 3) From the pulse life time curve determine the percentage derating required and select type C, D, F, G, J.
- 4) Confirm that the stored energy in the coil/capacitor ($\frac{1}{2}LI^2$, $\frac{1}{2}CV^2$) is within the capability of the selected device and if repetitive, is within the watts rating.
- 5) Read off from the characteristic curve the protection level (clamping voltage) at the peak current level.

If the source is not known it is only possible to select the correct voltage rating and form an intelligent estimate of likely phenomena from a knowledge of nearby plant.

On 240V mains the normal maximum peak current is below 20 Amps and slow acting switches etc. usually will not chop current above 10 Amps and very often it is as low as 3 Amps. Whilst these effects will still produce potentially devastating transients it is possible to obtain a good level of suppression with the D or G range, eg. Z250D will suppress a 1 Amp surge

to 600 volts, 10 Amps to 700 volts. The Z250G will suppress a 100 Amp surge to 750 volts. For exceptionally high current or repetitive industrial duties and induced lightning effects, the LP or P range of chassis mounting types should be considered.

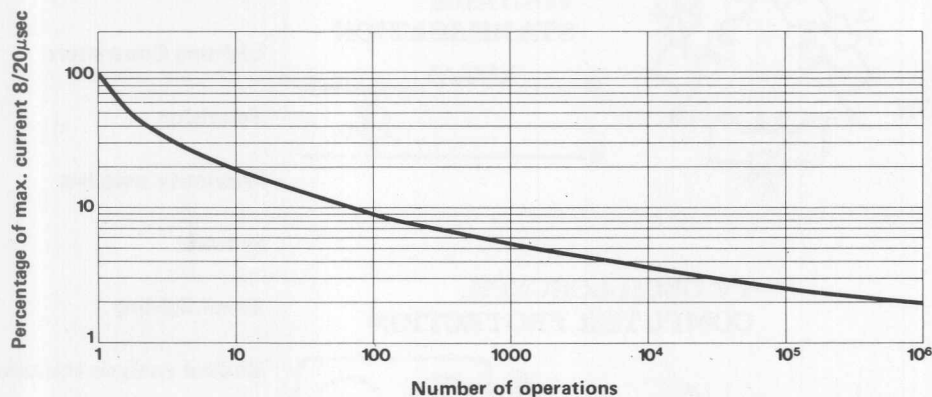
Non-Linear Index

At low-voltage Transient Clippers appear as a capacitor. As voltage increases this effect disappears and the device acts as a voltage dependent resistor following the law $V^\alpha \propto I$, where α is in the range of 25 to 50. This is maintained throughout the normal operating range of the device. At very high current densities in the order of hundreds of Amps per square centimetre, the non-linear index progressively reduces with the curve approaching that of a linear resistor until the voltage stress is so high that breakdown occurs due to puncture or flashover.

Stability & Life

Transient Clippers are designed to pass a quiescent current of only a few microAmps. Accelerated life tests indicate that this low current remains well below the acceptable watts loss figures for many years. It is becoming standard practice to monitor Zinc Oxide devices at 1mA. In order to give a more accurate basis of comparison on larger diameter devices we have standardised on 1.2mA/sq.cm. After 1,000 Hrs. type test at 85°C and maximum voltage the typical change in reference voltage at this level is -2%.

Derating for repetitive pulse duty is shown in the graph below where performance for multiple operations is given as a percentage of the maximum current. The 'life' considered is based on a change in reference voltage of 10% at 1.2mA/sq.cm.



Pulse lifetime ratings



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